GRADE 12 DIPLOMA EXAMINATION

Physics 30

June 1985

Alberta
EDUCATION

GRADE 12 DIPLOMA EXAMINATION
PHYSICS 30

DESCRIPTION

Time: 2½ hours

Total possible marks: 70

This is a **CLOSED-BOOK** examination consisting of two parts:

PART A: 56 multiple-choice questions each with a value of 1 mark.

PART B: Three written-response questions for a total of 14 marks.

A physics data booklet is provided for your reference. Approved calculators may be used.

GENERAL INSTRUCTIONS

Fill in the information on the answer sheet as directed by the examiner.

For multiple-choice questions, read each carefully and decide which of the choices BEST completes the statement or answers the question. Locate that question number on the answer sheet and fill in the space that corresponds to your choice. USE AN HB PENCIL ONLY.

Example

This examination is for the subject area of

A. Chemistry
B. Biology
C. Physics
D. Mathematics

Answer Sheet

A	B	C	D
①	②	●	④

If you wish to change an answer, please erase your first mark completely.

For written-response questions, read each carefully, show all your calculations, and write your answer in the space provided in the examination booklet.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

DO NOT FOLD EITHER THE ANSWER SHEET OR THE EXAMINATION BOOKLET

The presiding examiner will collect the answer sheet and examination booklet for transmission to Alberta Education.

JUNE 1985

PART A

INSTRUCTIONS

There are 56 multiple-choice questions with a value of one mark each in this section of the examination. Use the separate answer sheet provided and follow the specific instructions given.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

WHEN YOU HAVE COMPLETED PART A, PROCEED DIRECTLY TO PART B

DO NOT TURN THE PAGE TO START THE EXAMINATION UNTIL TOLD TO DO SO BY THE PRESIDING EXAMINER.

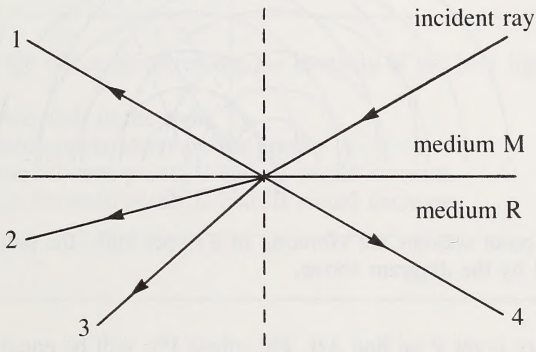
1. Early ideas about the nature of light often confused

   A. amplitude with intensity
   B. wavelength with color
   C. frequency with speed
   D. vision with light

2. When an object 30.0 cm high is placed 1.0 m from a pinhole camera, the image formed on the back of the camera 10.0 cm from the pinhole is

   A. 3.0 cm high and erect
   B. 3.0 cm high and inverted
   C. 30.0 cm high and erect
   D. 30.0 cm high and inverted

Use the following information to answer question 3.



Medium M has a lower index of refraction than medium R.

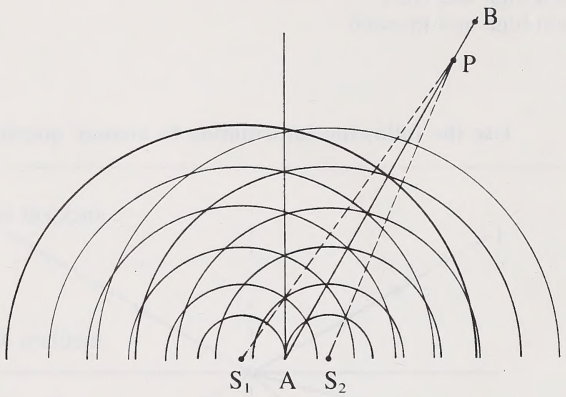
3. The ray representing the refracted light is

   A. 1
   B. 2
   C. 3
   D. 4

4. Young's double-slit experiment is performed with a slit separation of 2.0×10^{-5} m. The distance from the centre of the slits to the screen is 1.0×10^{-1} m. The first bright fringe, 1.0×10^{-3} m from the centre line, is produced by light with a frequency of

A. 1.5×10^{15} Hz
B. 1.5×10^{13} Hz
C. 6.0×10^{15} Hz
D. 6.6×10^{15} Hz

Use the following information to answer question 5.



When two point sources are vibrating in a ripple tank, the pattern created can be represented by the diagram above.

5. For an arbitrary point P on line AB, PS_1 minus PS_2 will be equal to

A. 1.0λ
B. 1.5λ
C. 2.0λ
D. 2.5λ

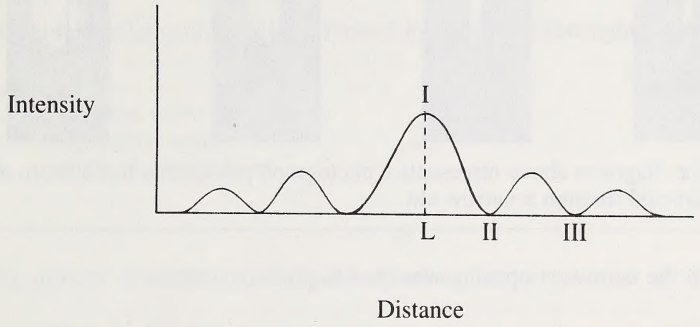
---

6. A MINIMUM amount of scattering occurs when waves of

A. long wavelength interact with a large obstacle
B. short wavelength interact with a large obstacle
C. long wavelength interact with a very small obstacle
D. short wavelength interact with a very small obstacle

Use the following information to answer question 7.

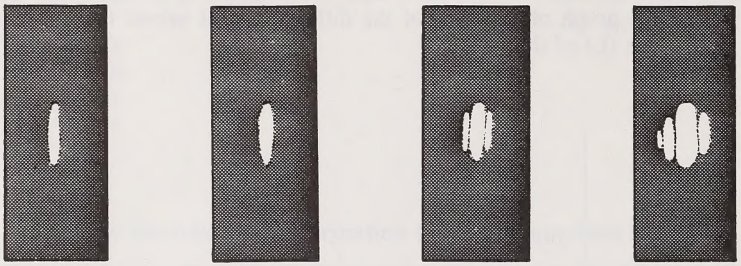
A monochromatic beam of blue light is diffracted by a single slit. The diagram shows the graph of intensity of the diffracted light versus the distance from the centre line (L) of the pattern.



7. What would be the effect of decreasing the intensity of the blue light?

A. Point I would shift to the right.
B. Point I would appear lower on the graph.
C. The distance between points II and III would increase.
D. The distance between points II and III would decrease.

Use the following information to answer question 8.



Each of the diagrams above represents a photograph produced when a beam of red light is directed through a narrow slit.

8. The slit with the narrowest opening was used to produce diagram

A. I
B. II
C. III
D. IV

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9. A shadow is cast on a wall. Around the edge of the shadow is a series of dark and bright lines resulting from

A. dispersion
B. diffraction
C. refraction
D. scattering

Use the following information to answer question 10.

I Red sunsets
II Radio blackouts
III Blue sky overhead
IV Rainbows

10. The longer a wave is, compared with the size of an obstacle, the less the wave is scattered by the obstacle. This phenomenon accounts for

A. I and III
B. I and IV
C. II and III
D. II and IV

---

11. Light with the longest wavelength is

A. yellow
B. violet
C. blue
D. red

12. To explain polarization of light, Fresnel hypothesized that light behaves as a

A. particle
B. transverse wave
C. longitudinal wave
D. quantized energy form

13. The process of electrostatic induction involves the

A. removal of charge
B. addition of charge
C. redistribution of charge
D. addition and redistribution of charge

14. The electrostatic force of repulsion between two electrons separated by 1.0×10^{-10} m is

A. 1.4×10^{11} N
B. 1.4×10^{1} N
C. 1.0×10^{-7} N
D. 2.3×10^{-8} N

15. A small positive test charge experiences the largest electric force when placed

A. at the centre of a charged spherical conductor
B. anywhere inside a charged spherical conductor
C. just inside the surface of a charged spherical conductor
D. just outside the surface of a charged spherical conductor

16. Two small negatively charged spheres separated by a distance repel each other. If the separation of the spheres is doubled, the force of repulsion becomes

A. one fourth as great
B. four times as great
C. one half as great
D. twice as great

17. The term ''electric field'' describes

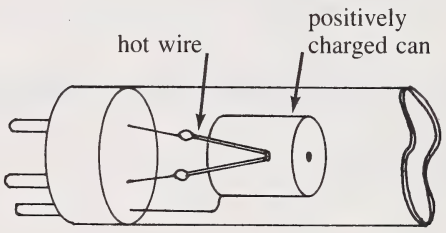
A. a field that carries an electric charge
B. an area of electrical influence surrounding a charge
C. a field that will always cause uncharged objects to become charged
D. an area of electrical influence that always has a magnetic field associated with it

18. The electrical potential difference between two points is one volt if one joule of work is done in moving one

A. faraday from one point to the other
B. electron from one point to the other
C. ampere of charge from one point to the other
D. coulomb of charge from one point to the other

Use the following information to answer question 19.

Electron Beam Tube



19. In the electron beam tube, the wire is heated to

A. emit light so that the beam path can be seen
B. create a potential difference between the wire and the charged can
C. cause emissions of electrons from the wire to form the electron beam
D. give electrons sufficient kinetic energy to travel to the end of the beam

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20. In the absence of other forces, a charged particle in an electric field will

A. experience an acceleration
B. be forced to move in a circular path
C. adjust its charge to maintain equilibrium within the field
D. remain stationary, dependent on its charge and the strength of the field

21. The potential difference across a 12Ω resistor is 120 V. What power does the resistor consume?

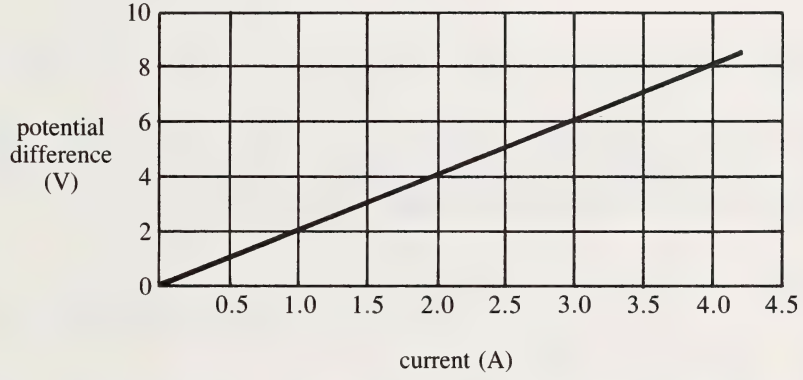
A. 1.4×10^3 W
B. 1.2×10^3 W
C. 1.7×10^5 W
D. 4.3×10^6 W

22. An alpha particle enters a magnetic field of 5.0×10^{-3} T with a velocity of 1.2×10^3 m/s perpendicular to the field. The radius of the particle's path is

A. 5.0×10^{-3} m
B. 1.0×10^{-2} m
C. 3.2×10^3 m
D. 1.8×10^{28} m

Use the following information to answer question 23.

The graph below shows the potential difference across a fixed resistance for different values of the current in the resistance.



23. The resistance is

A. 3Ω
B. 2Ω
C. 1Ω
D. 0.5Ω

24. When two parallel wires carry currents in the same direction, they are

A. repelled due to the interaction of their electric fields
B. repelled due to the interaction of their magnetic fields
C. attracted due to the interaction of their electric fields
D. attracted due to the interaction of their magnetic fields

25. The Van Allen belts are

A. devices used to produce high voltages
B. layers of the ionosphere affected by the aurora
C. bands of ionizing radiation protecting the Earth from cosmic rays
D. regions of electrons and protons trapped in the Earth's magnetic field

26. A charged object passes perpendicularly through a magnetic field of 1.0 T at 5.0 m/s. In order for the object to experience a force of 8.0×10^{-10} N, the number of excess electrons the object must have is

A. 1.6×10^{-16}
B. 1.0×10^{3}
C. 1.0×10^{9}
D. 6.2×10^{18}

27. Electromagnetic induction will occur when a

A. magnet is held within a loop of wire
B. magnet is moved through a loop of wire
C. loop of wire is held in a steady magnetic field
D. loop of wire is moved parallel to the magnetic field

28. All forms of electromagnetic radiation

A. travel only in a vacuum
B. are produced by radioactivity
C. travel with the same speed in a vacuum
D. have the same frequency but different wavelengths

29. Microwave radiation of wavelength 8.3×10^{-2} m is produced by a spark-coil apparatus similar to that used by Hertz. What is the period of this radiation?

A. 2.8×10^{-10} s
B. 4.0×10^{-8} s
C. 2.5×10^{7} s
D. 3.6×10^{9} s

30. The experiments done by Hertz confirmed the existence of electromagnetic radiation, and showed that this radiation

A. absorbs energy
B. is present everywhere
C. has properties similar to visible light
D. can be produced only by an induction coil

31. If power costs 2¢/MJ, the cost (calculated to the nearest dollar) to operate a 1500 W coffee percolator for 20 minutes a day for 300 days will be

A. $8
B. $11
C. $18
D. $30

32. If gamma radiation has a frequency of 1.0×10^{24} Hz, its wavelength is

A. 3.0×10^{32} m
B. 3.3×10^{15} m
C. 3.0×10^{-16} m
D. 3.3×10^{-24} m

33. Which statement applies to ALL forms of electromagnetic radiation?

A. The wavelength of electromagnetic radiation is constant.
B. Powerful electromagnets can deflect electromagnetic radiation.
C. Heat is usually produced when electromagnetic radiation is absorbed.
D. The speed of electromagnetic radiation has the same value in all media.

34. When high-speed electrons hit a metallic conductor and stop suddenly, the rays primarily produced by the process are called

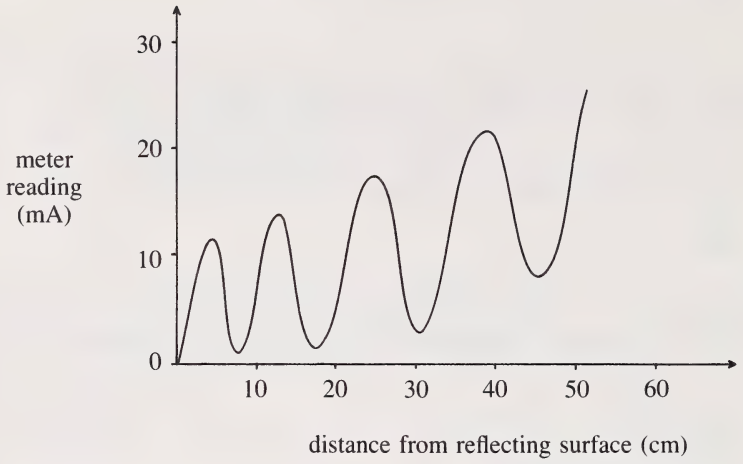
A. X-rays
B. solar rays
C. gamma rays
D. infra-red rays

35. Experimental evidence contradicting the existence of an ether was provided by

A. Hertz and Maxwell
B. Hull and Lebedev
C. Einstein and Planck
D. Michelson and Morley

Use the following information to answer question 36.

This graph is a representation of data gathered in an experiment to investigate the reflection of microwaves from a surface that is perpendicular to the microwave source.



36. The variation in the meter reading is due to

A. interference
B. polarization
C. diffraction
D. absorption

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37. In an electrolysis experiment, a current of x amperes flowing for y seconds produces 30.0 g of zinc. If a current of $4x$ is used for $y/6$ seconds, the mass of zinc produced will be

A. 20.0 g
B. 45.0 g
C. 90.0 g
D. 120 g

38. In which fields will alpha rays experience a force?

A. Electric and magnetic only
B. Electric and gravitational only
C. Magnetic and gravitational only
D. Magnetic, electric, and gravitational

39. An oil droplet with a charge of $5e$ falls between two horizontal plates that are 2.0 cm apart. The oil droplet is suspended when 3.0×10^2 V are applied across the plates. What is the mass of the oil droplet?

A. 7.5×10^{-11} kg
B. 7.5×10^{-15} kg
C. 1.2×10^{-15} kg
D. 2.4×10^{-16} kg

40. The energy of a photon with a wavelength of 4.0×10^{-7} m is

A. 8.8×10^{-49} J
B. 2.6×10^{-41} J
C. 1.7×10^{-27} J
D. 5.0×10^{-19} J

41. X-rays of wavelength 5.0×10^{-11} m strike a free electron at rest. The free electron rebounds with a velocity of 2.0×10^6 m/s. The scattered X-ray strikes a metallic surface whose work function is 5.2×10^{-16} J. What is the maximum velocity of an emitted photoelectron?

A. 8.0×10^7 m/s
B. 2.0×10^6 m/s
C. 5.4×10^5 m/s
D. 4.3×10^4 m/s

42. The theory that atoms have concentrated charged nuclei is supported by

A. Thomson's sphere of positive electricity
B. calculations using $1/\lambda = R_H[(1/2^2) - (1/n^2)]$
C. the unexpected angular deflection of alpha particles
D. the observation that X-rays can travel through atoms

43. The frequency of the spectral line for $n_i = 3$ in the Balmer series ($n_f = 2$) is

A. 3.7×10^{14} Hz
B. 4.6×10^{14} Hz
C. 5.6×10^{14} Hz
D. 1.2×10^{15} Hz

44. Bohr postulated quantized atomic orbits, suggesting that observed line spectra correspond to

A. the energies of each electron in the atom
B. the resonant transfer of energies between electrons and protons
C. energies created by combining protons and neutrons in the nucleus
D. energy absorption or emission when electrons make a transition between stationary states

45. Which statement is INCORRECT?

A. Planck introduced the concept of quantization.
B. Roentgen reported that X-rays are not affected by magnetic fields.
C. The Thomson atomic model does not account for the quantization of energy.
D. Millikan demonstrated a direct relationship between maximum E_k of photoelectrons and frequency of incident light.

46. Relativistic effects are NOT readily apparent in our everyday world because the

A. speed of light in a vacuum is constant
B. ether is extremely difficult to detect
C. speed with which we move is much less than the speed of light
D. non-accelerating frames of reference are very difficult to establish

47. The momentum of an alpha particle accelerated to 40% of c is

A. 1.1×10^{-18} kg•m/s
B. 2.2×10^{-19} kg•m/s
C. 8.7×10^{-19} kg•m/s
D. 8.0×10^{-27} kg•m/s

Use the following information to answer question 48.

In an experiment, X-rays are scattered from a variety of materials. Some of the scattered radiation is observed to have a lower frequency than the incident radiation.

48. Which statement concerning this experiment is FALSE?

A. The experiment described is an example of the Compton effect.
B. The lower frequency is a result of a transfer of energy to electrons in the materials.
C. The principles of conservation of energy and momentum are obeyed in this experiment.
D. The observed change in frequency provides evidence for the wave nature of visible light.

49. For an electron to have the same momentum as a photon with a wavelength of 6.0×10^{-7} m, the electron would have to move with a speed of

A. 1.1×10^{-27} m/s
B. 8.3×10^{-4} m/s
C. 6.6×10^{2} m/s
D. 1.2×10^{3} m/s

50. The particle model of light explains

A. interference and reflection
B. interference and diffraction
C. the Compton effect and diffraction
D. the Compton effect and the photoelectric effect

51. A proton is predicted to have a de Broglie wavelength of 6.0×10^{-15} m. The proton's speed will be

A. 6.6×10^{7} m/s
B. 1.6×10^{7} m/s
C. 1.2×10^{7} m/s
D. 6.6×10^{6} m/s

Use the following information to answer question 52.

A charged particle with a mass of 1.8×10^{-28} kg is accelerated across a 1.0×10^{2} V potential difference and exhibits a de Broglie wavelength of 1.2×10^{-10} m. When the acceleration voltage is doubled, the new de Broglie wavelength is 8.5×10^{-11} m.

52. If the original acceleration voltage is tripled, the new de Broglie wavelength will be

A. 4.0×10^{-11} m
B. 6.9×10^{-11} m
C. 2.1×10^{-10} m
D. 3.6×10^{-10} m

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53. The wavelength of a proton moving at a speed of 1.0×10^{6} m/s is

A. 4.0×10^{-55} m
B. 2.5×10^{-13} m
C. 4.0×10^{-13} m
D. 2.5×10^{-12} m

54. According to de Broglie, the wavelength of an electron in the third energy level of the hydrogen atom would be

A. 2.99×10^{-9} m
B. 1.59×10^{-10} m
C. 4.98×10^{-10} m
D. 9.97×10^{-10} m

55. If the uncertainty in the position of an electron is 2.0×10^{-5} m, the minimum uncertainty in its momentum is in the order of

A. 10^{-39} kg•m/s
B. 10^{-30} kg•m/s
C. 10^{-29} kg•m/s
D. 10^{-19} kg•m/s

56. To determine the probability of finding an electron in a specific place, one would use

A. the Compton effect
B. Bohr's atomic model
C. the de Broglie relation
D. Schrödinger's wave equation

YOU HAVE NOW COMPLETED THE MULTIPLE-CHOICE SECTION OF THE EXAMINATION. PLEASE PROCEED TO THE NEXT PAGE AND ANSWER THE WRITTEN-RESPONSE QUESTIONS IN PART B.

PART B

INSTRUCTIONS

Please write your answers in the examination booklet as neatly as possible.

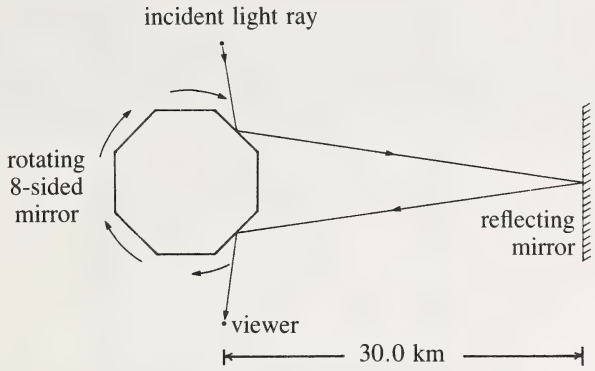
Marks will be awarded for pertinent explanations, calculations, formulas, and answers. Answers must be given to the appropriate number of significant digits.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

TOTAL MARKS: 14

START PART B IMMEDIATELY

Use the following information to answer question 1.



The apparatus is being used in an experiment similar to one conducted by Michelson for calculating the speed of light. The 8-sided mirror is rotating at a rate of 6.0×10^4 rpm.

(2 marks) 1. a. If the incident light and the reflected light touch the same section of the mirror, determine the time interval required for the light to return to the rotating mirror.

answer _____

(1 mark) **b.** Calculate the apparent speed of light for this experiment.
(NOTE: Only if you were unable to determine a value for part a of this question, use the hypothetical value of 3.1×10^{-4} s.)

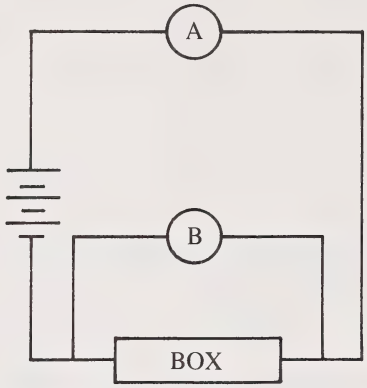
answer _____

(1 mark) **c.** Calculate the percentage error in your calculated value for the speed of light.

answer _____

Use the following information to answer question 2.

In an experiment, an ammeter and a voltmeter were connected in a simple circuit as shown. There was a simple electrical device of unknown properties located inside the apparatus labelled "BOX." The current was adjusted to the values shown and the potential difference was then measured. Some of the electrical properties of the device within the box are being investigated in this experiment.

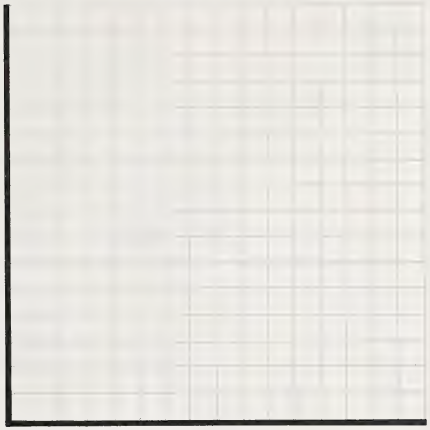


The following information was recorded:

Current, I (A)	Potential Difference, V (V)
0.4	2.0
1.2	5.0
1.8	8.0
3.0	13.0
3.4	14.0
3.5	14.8

(1 mark) 2. a. For what purpose would a scientist graph this data?

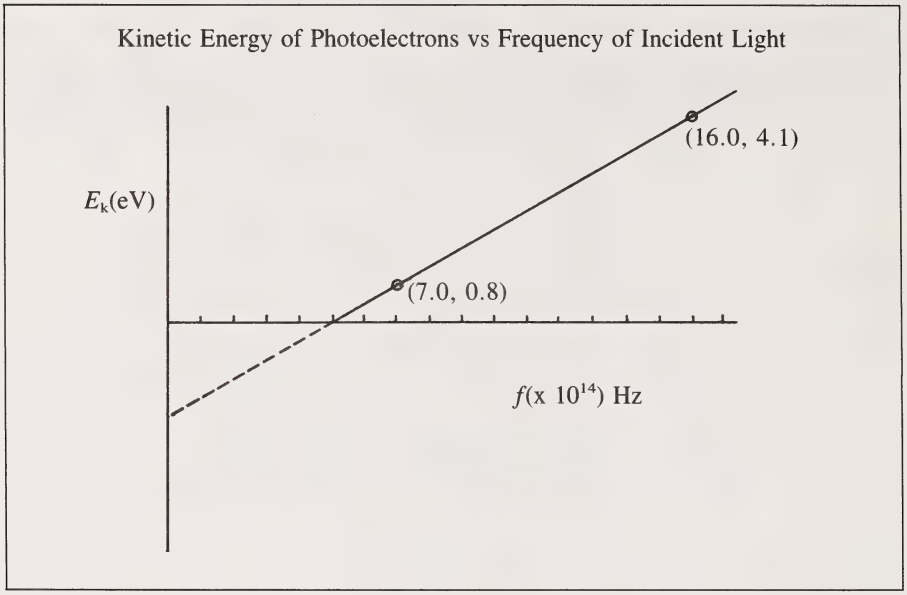
(2 marks) **b.** Plot the data on the graph provided.



(1 mark) **c.** State the relationship between current and potential difference in a mathematical form.

(1 mark) **d.** From the evidence presented in the graph, what simple electrical component could be inside the box to produce these data?

Use the following information to answer question 3.



(2 marks) 3. a. Determine Planck's constant from the data given. Show all your calculations.

(3 marks)

b. Calculate the value of the work function of the metal. Show all your calculations. Express your answer to the appropriate number of significant digits and include appropriate units.

YOU HAVE NOW COMPLETED THE EXAMINATION. IF YOU HAVE TIME, YOU MAY WISH TO GO BACK AND CHECK YOUR ANSWERS.

TEAR-OUT SHEET

(NO MARKS WILL BE GIVEN FOR WORK DONE ON THIS PAGE)

FOLD AND TEAR ALONG PERFORATION

TEAR-OUT SHEET

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M1 M2

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PHYSICS 30

(LAST NAME) (FIRST NAME)

NAME:

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